Name: ______________________________

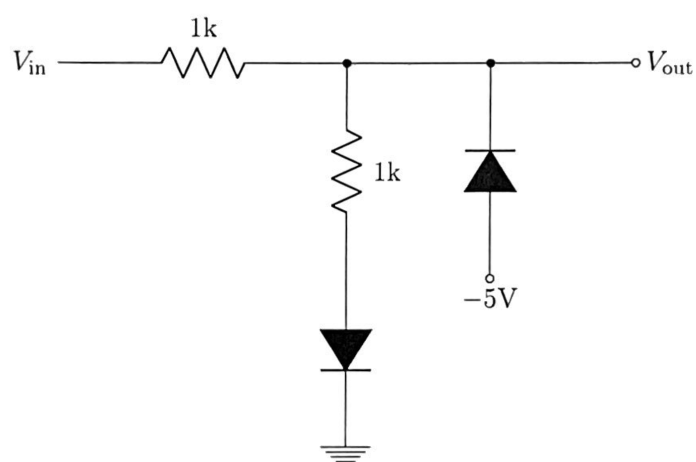
Electronics for Scientists

Final Exam

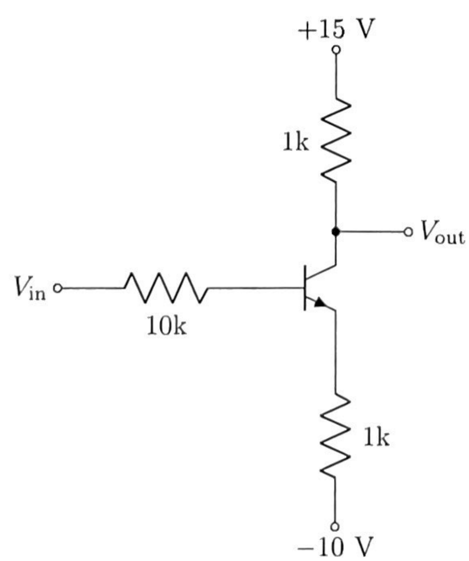
Instructions

Complete the following exercises to the best of your ability. Do not forget your units and show your work! Answers without units or supporting work will be graded incorrect.

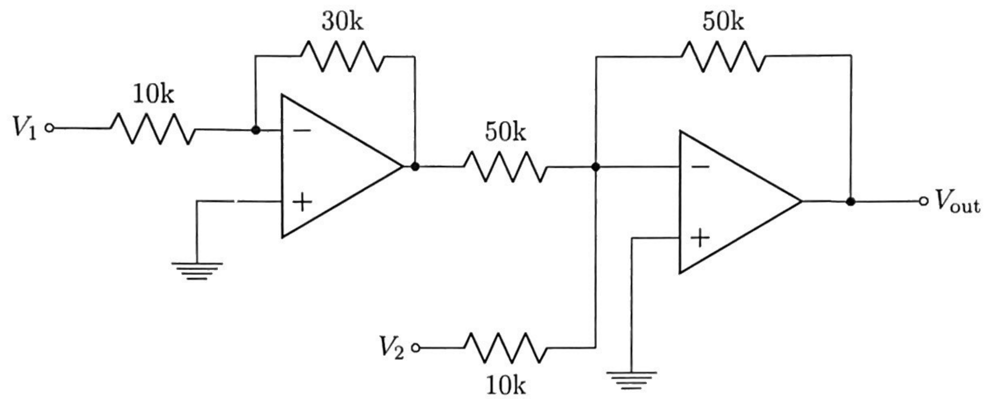
1. A 10 V AC signal is applied to the input of the below circuit. Sketch the output voltage as a function of time. Assume there is a 0.6 V voltage drop across the diodes. [15 points]



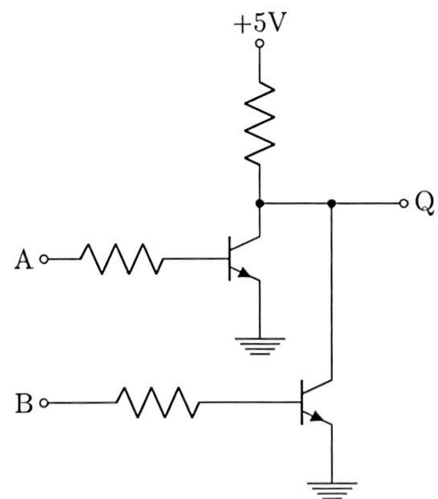
2. The following circuit contains a transistor where $\beta = 100$. A 5 V AC signal is applied to the input. Sketch V_{out} as a function of time. [14 points]



3. Write out an expression for V_{out} in terms of V_1 and V_2. [15 points]



4. Assuming inputs A and B can be either 0 or +5 V, what logic gate does the following transistor circuit behave as? Create a truth table for the circuit. [14 points]



5. Convert the following numbers from one base to another. The subscript represents what base the number is currently expressed as. [12 points]

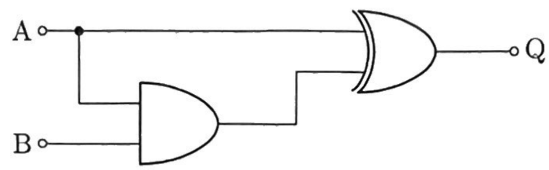
(a) $4BA_{16}$ to decimal.

(b) $4BA_{16}$ to binary.

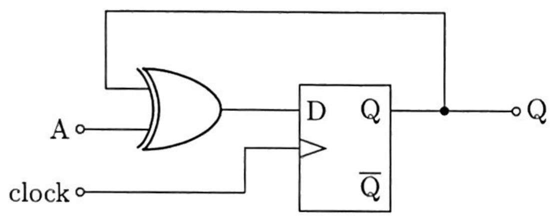
(c) 11011101_2 to decimal.

(d) 11011101_2 to hexadecimal.

6. Complete a truth table for the below circuit. [15 points]

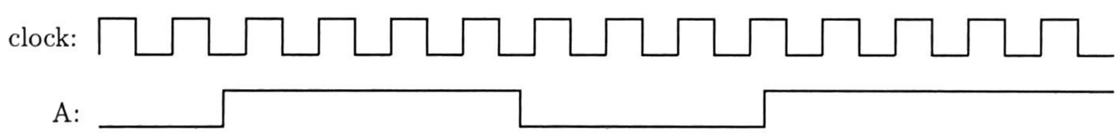


7. A square wave clock signal is input into the below circuit containing a positive-edge-triggered D flip flop. The truth table of the D flip flop is also shown.



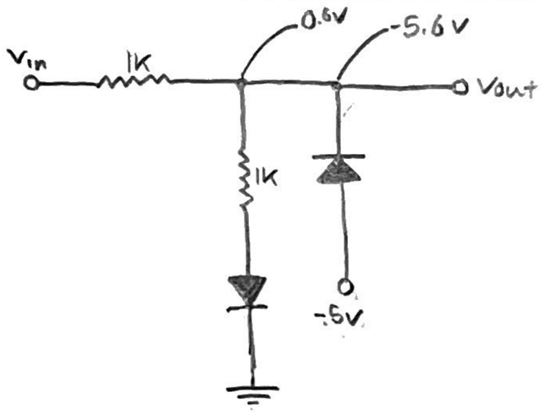
D	clock	Q
0	0	unchanged
1	0	unchanged
0	1	0
1	1	1

Using the timing diagram for the A and clock inputs, sketch the resulting output signal at Q. Assume that Q starts low. *It may be helpful to also draw a timing diagram for the XOR output.* [15 points]



Taylor Larrechea
Dr. Hostermen
Phys 251 Final

P1:



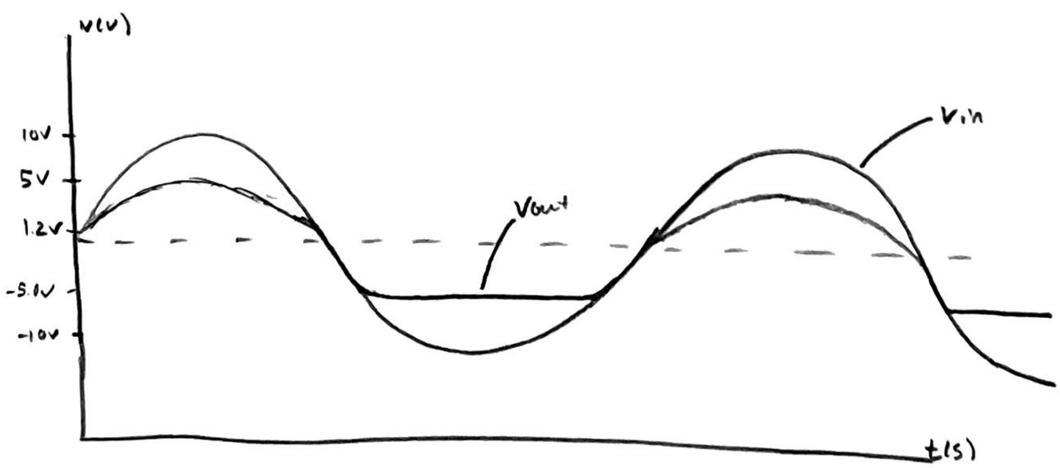
$V_{in} = 10\,V$

Sketch V_{out} ...

$$V_{in} - I(2K) - 0.6V = 0$$

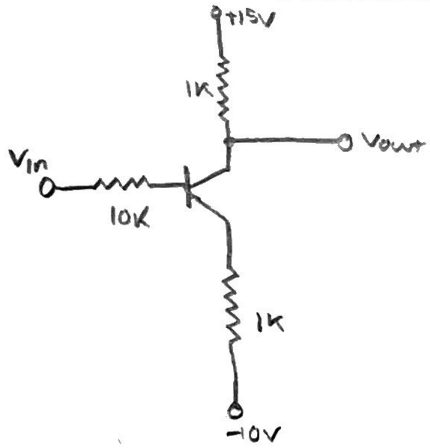
$$-I(2K) = -9.4V$$

$$I = 4.7\,mA$$



Taylor Larrechea
Dr. Hosterman
PHYS 251 Final

P2:



$\beta = 100$

$I_E = \beta I_B$

$I_c = \beta I_B$

$$V_{in} - I_B(10k) - I_E(1k) = -10V$$

$$V_{in} - I_B(10k) - \beta I_B(1k) = -10V$$

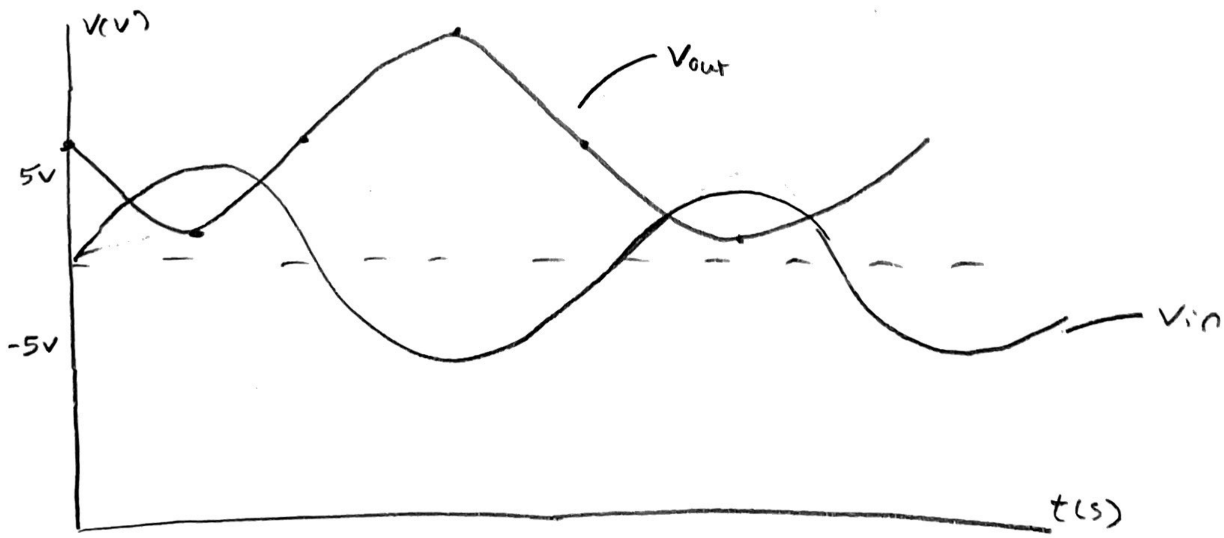
$$I_B(10k + \beta 1k) = V_{in} + 10V$$

$$I_B = \frac{V_{in} + 10V}{110k}$$

$$15v - I_c(1k) = V_{out}$$

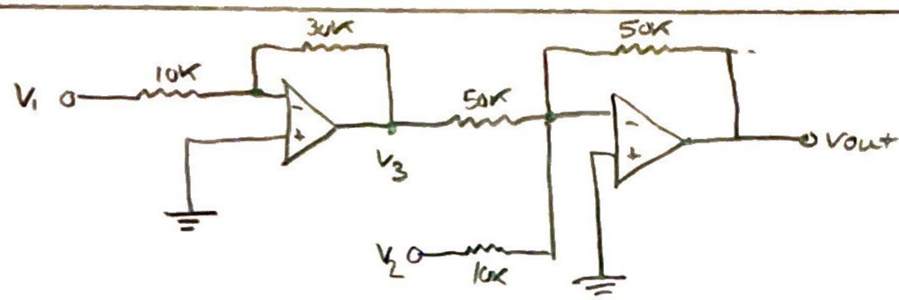
$$15v - \frac{(v_{in} + 10v)(1k)\beta}{(110k)} = V_{out}$$

$$15v - \frac{10}{11}(v_{in} + 10v) = V_{out}$$



Taylor Larrechea
Dr. Hosterman
PHYS 251 Final

P3:



Negative feedback ∴ no current through inputs

$$V_3 = -\left(\frac{30K}{10K}\right)V_1$$

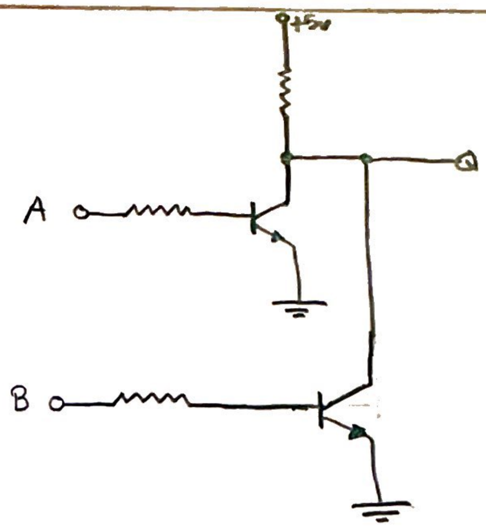
$$V_{out} = -\left(\frac{50K}{50K}\right)V_3 - \left(\frac{50K}{10K}\right)V_2$$

$$V_{out} = 3V_1 - 5V_2$$

$$\boxed{V_{out} = 3V_1 - 5V_2}$$

Taylor Larrechea
Dr. Hosterman
PHYS 251 Final

P4:



A high : Transistor on ; connected to ground
else : Transistor OFF
B high : Transistor on : connected to ground
else : Transistor off

A	B	Q
0	0	1
1	0	0
0	1	0
1	1	0

$\boxed{\text{NAND Gate}}$

Taylor Larrechea
Dr. Hosterman
PHYS 251 Final

P6:

(a) $4BA_{16}$ to decimal.

$$4\cdot 16^2 + 11\cdot 16^1 + 10\cdot 16^0 = 1210_{10}$$

$$\boxed{4BA_{16} = 1210_{10}}$$

(b) $4BA_{16}$ to binary.

$4BA_{16} = 1210_{10}$

$\frac{1210}{2}$: $r=0$

$\frac{605}{2}$: $r=1$

$\frac{302}{2}$: $r=0$

$\frac{151}{2}$: $r=1$

$\frac{75}{2}$: $r=1$

$\frac{37}{2}$: $r=1$

$\frac{18}{2}$: $r=0$

$\frac{9}{2}$: $r=1$

$\frac{4}{2}$: $r=0$

$\frac{2}{2}$: $r=0$

$\frac{1}{2}$: $r=1$

$$\boxed{4BA_{16} = 10010111010_2}$$

Taylor Larrechea
Dr. middleton
Phys - 230

P5 cont:

c.) 11011101_2 to decimal

$$1\cdot 2^7+1\cdot 2^6+0\cdot 2^5+1\cdot 2^4+1\cdot 2^3+1\cdot 2^2+0\cdot 2^1+1\cdot 2^0 = 221$$

$$\boxed{11011101_2 = 221_{10}}$$

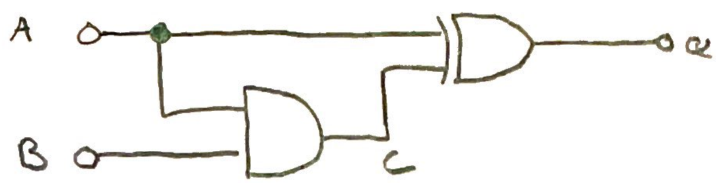
d.) 11011101_2 to hexadecimal

		Q	r
$\frac{221}{16}$	=	13	13
$\frac{13}{16}$	=	0	13

$$\boxed{DD_{16} = 11011101_2}$$

Taylor Larrechea
Dr. Hosterman
PHYS 251 Final

P6:



AND Gate

A	B	Q
0	0	0
1	0	0
0	1	0
1	1	1

XOR Gate

A	C	Q
0	0	0
1	0	1
0	1	1
0	0	0

Complete Circuit

A	B	C	A	Q
0	0	0	0	0
1	0	0	1	1
0	1	0	0	0
1	1	1	1	0

Taylor Larrechea
Dr. Hosterman
PHYS 251 Final

P7: